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The colours of thin blowpipe deposits

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sary, and that we may form quite a distinct idea of the nature of thermo-electricity when viewed from a different standpoint.

When we consider that the theory of the galvanic cell as at present existing rests altogether on the assumption of voltaic contact force, we may well expect the most radical changes in this direction; and, so far as I can at present see, the theory of the cell may be represented in a considerably simpler manner and on more natural principles than heretofore.

The results of a more searching investigation of these matters shall be reserved for future publication.

XXXVII. *Intelligence and Miscellaneous Articles.*

THE COLOURS OF THIN BLOWPIPE DEPOSITS. BY C. H. KOYL,
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SOME examples of the action of very fine particles of matter upon light having lately come to my notice, it may be interesting to make them public, as they have heretofore, I believe, been unexplained.

Those who are familiar with the methods of blowpipe analysis have observed faint borders occasionally surrounding some of the coloured charcoal coatings, the colours of these borders seemingly bearing no relation to the characteristic colours of the adjoining oxides. For instance, the white coating of antimony is generally accompanied with a blue border, the brownish oxide of cadmium occasionally with a green, while the lead and bismuth yellows not unfrequently have a whitish ring inclosing them. As these occur only and always where the coating is very thin, they have a significance different from that of the ordinary colours, and as they may be produced at pleasure from the purest specimens, they cannot be due to mixtures of the metals. A possible analogy with the antimony blue was suggested by a consideration of the colours of the sky; and to prove the connection, it was simply necessary to show the similarity of attendant phenomena. As is well known, it is believed that the blue of the sky is due to the presence in the atmosphere of suspended particles so fine that they are unable to reflect the longer rays of the spectrum, which accordingly are transmitted, and the union of the remainder gives to the sky its blueness. At evening the sky is red because we get the rays of the sun directly transmitted or reflected from the clouds. Thirdly, the light of the sky, reflected at an angle of 90° with the sun, is plane-polarized.

When an antimony coating had been produced which gave, beyond the white oxide, a blue well defined and full, the whole was illuminated in a dark room by a sodium flame; and that the blueness was no psychical or physiological effect as distinguished from ordinary vision, was proved by the fact that here it almost

completely vanished, while the white presented the usual ghastly appearance. A blue book-cover, treated in the same manner, gave more reflection than did the blue coating.

Experiments with the polariscope were at first inconclusive, from the fact that though the light from the blue coating was largely polarized, so, to some extent, was also that irregularly reflected from the charcoal, and it was found necessary to cover the block with a thin layer of carbon from a gas-flame. The repetition of the test then showed that the proportion of light polarized by the layer of carbon, at the given angle, was almost nothing; that by the thick white coating, small, while on the blue the phenomenon was almost complete. What light here was not polarized was evidently reflected from the larger particles mixed with the fine; for the analyzer, while it did not totally extinguish the light, yet excluded nearly all appearance of blueness.

In order to determine the character of the transmitted light, a microscope covering-glass was inlaid in the charcoal and the oxidation so executed that the glass was in the centre of a small area, all of which was blue. On removing the glass, the light which passed through proved to be of the expected yellow, though less brilliant than anticipated. The colour might be seen either by transmitting the direct light of the sun, or by placing the glass at such an angle that total reflection was produced, and thus in the passage of the rays through the layer to the glass and out through the layer to the eye the blue was principally lost and only the mixture of longer rays appeared. Viewed through a microscope, the result was the same. I have since, however, improved upon this plan by the more convenient method of covering with carbon a piece of ordinary window-glass, three inches by two, and then projecting the oxide upon the *opposite* surface of the plate. There is thus no difficulty in distinguishing a very slight amount of colour in the coating; and for transmitted light any portion of the carbon may be easily removed.

This case, a type of all charcoal coatings which shade off to blue in thin layers, appears thus parallel to that of the sky-colour; and the theory which is accepted for the one will also satisfactorily explain the other.

To account for the cadmium-green we have only to note that, if the substance upon which we are experimenting have the power of absorbing the shorter rays of the spectrum, the reflected light would from a heavy coating be yellowish or reddish, the particular shade depending upon the amount of absorption of violet and blue, and the formation of a layer as thin and of particles as fine as before should result in giving us the colour of the shortest rays which the substance is capable of reflecting, viz. in this case, green. The coating of cadmium has exactly this appearance, and shows the effect of the gradual transmission of red by shading from the original colour (dark red) through yellow into a fine green. As before, the light reflected from the thin layers is highly polarized, and the rays which pass through form a deep, dark red.

In exceptional cases it is possible to produce such a thin coating that the extreme edge is fringed with a faint blue.

The other case, lead, is now easily explained. This metal gives a coating of which the colour is a beautiful chrome yellow; and regarding this merely as a repetition of the preceding phenomenon, and the yellow as compounded of rays from the whole range of the spectrum but not in the proper proportion to form white, the line of thought suggested evidently is that, if the layer be decreased in thickness regularly from the centre to the circumference of the charcoal, there ought to be, at some distance from the centre, a zone within which sufficient red should be transmitted to equalize the amount of blue lost by absorption, and the reflected rays should form a yellowish white. Beyond this, as the thickness of layer still decreased, the colour should be blue for the same reason as in the case of antimony. The white zone is easily produced; and the blue border which always surrounds it polarizes the light as before and transmits orange-coloured rays.

The theory, once given, serves to explain nearly all the anomalous colourings of the charcoal coatings, the bluish borders which occasionally skirt almost any of the metallic oxides, the "peacock-tails" of cadmium, etc., and thus does away with the necessity of supposing the presence of impurities (though, by the way, no impurity would solve the problem in the case of the cadmium green.)

From a physical standpoint, the experiments seem interesting as an extension of our knowledge of the action of these small particles upon light. Had not the subject presented itself in this way, we would scarcely have guessed that such a change in reflecting-power could have been produced by so small a change in size and thickness.—Silliman's *American Journal*, September 1880.

Baltimore, Md., July 9, 1880.

ON AN AREOMETER FOR DETERMINING THE DENSITY OF SOLID BODIES. BY M. BUGUET*.

The author makes the rod of a Nicholson's areometer thicker and longer than it usually is, denotes by o and n the depth to which it sinks when unloaded and when loaded with n grams, and graduates the interval into parts corresponding to cubic centimetres and their subdivisions. If, when the body to be investigated is on the upper pan the areometer sinks to the division-mark P , and when on the lower to P' , the specific gravity is $\frac{P}{P-P'}$.—Wiedemann's *Beiblätter*, 1880, No. 7, p. 497.

DETERMINATION OF THE SPECIFIC GRAVITY OF SMALL FRAGMENTS OF MINERALS. BY J. THOULET†.

A solid body is pressed into a small ball of wax, so that the mean

* *Journ. de Phys.* ix. pp. 93, 94 (1880).

† *Z.-S. f. Kryst.* iv. p. 421 (1880); *Bull. Soc. Min.* ii. p. 189 (1879).
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